



Contact-Dynamics Simulation Laboratory

Purpose:

To provide a simulation testbed for the study of the contact-dynamics of full-scale docking and berthing mechanisms.

As different space vehicles were developed, interfaces between the vehicles were also developed, creating a need to verify the operation of the interfaces. The Marshall Space Flight Center's Contact-Dynamics Simulation Laboratory (CDSL) was developed in response to the need to evaluate the Earth-orbit dynamic response of the interfacing mechanisms. This facility allows engineers to simulate how a docking or berthing mechanism would behave in earth orbit under a variety of conditions. This simulation can be used to determine the capture envelope of docking and berthing devices. It can also reveal the stresses a device will experience once in space through the use of force and torque data recorded during a simulation. Past simulations have resulted in the re-design of some mechanisms, improving their performance, and ensuring that they could perform the task for which they were designed.

In the CDSL, one component is attached to a motion-base, while the other component is mounted to a force and torque sensor fixed in the support structure above the motion-base. The motion-base is a hydraulically driven CAE-LINK Stewart Platform which is used to simulate the relative motion of the berthing and docking mechanisms in six degrees of freedom. The motion-base is commanded by an Alliant FX-80 parallel super computer, which runs a simulation program modeling two vehicles in earth orbit. When the two components of the mechanism touch, the force and torque sensor sends the contact forces and torques to the Alliant computer, which then uses the information to calculate the resulting motion of the simulated vehicles. The computer calculates the relative motion of the simulated vehicles and commands the motion-base to move appropriately. As the motion-base moves, several safety sensors are checked to ensure the test article is not damaged by the motion-base.

The computer drives several control panels allowing engineers to monitor the simulation. The computer also sends data to Silicon Graphics workstations to drive graphics displays of the simulated vehicles. Further, the CDSL has the ability to simulate the manual control of a vehicle.

The simulation can be used to dock or berth two distinct vehicles, or the simulation can be used to berth two objects together using the Shuttle Remote Manipulator System (SRMS). The two-body simulation has the capability of modeling flexible body vehicles and of modeling different control systems for the vehicles. The SRMS simulation is a complete flexible body simulation capable of simulating the flexible booms and joints of the SRMS, the joint servos, the SRMS control system, as well as flexible payloads and base vehicles.

The CDSL is currently testing the Boeing Common Berthing Mechanism, which will be used to attach International Space Station (ISS) modules together.

POINT-OF-CONTACT:

Fred Roe / ED19
(256) 544-3512
fred.roe@msfc.nasa.gov